Plant Pathology Bulletin 7:113-119, 1998

Effect of Varietal Difference, Temperature, Shading and Plant Age on SO_2 Sensitivity Among Rice, Corn and Soybean Plants

Shih-Pan-Yu Hsieh, Ming-Chang Leu, Shih-Ting Kao, Shu-Fen Shiau and Dean Der-Syh, Tzeng

Department of Plant Pathology, National Chung Hsing University, Taichung, Taiwan, R. O. C.
Accepted for publication: June 15, 1998.

ABSTRACT

Hsieh, S. P. Y., Kao, S. T., Leu, M. C., Shiau, S. F., and Tzeng, D. D. 1998. Effect of varietal difference, temperature, shading and plant age on SO_2 sensitivity among rice, corn and soybean plants. Plant Pathol. Bull. 7:113-119.

The effect of varietal difference, temperature, shading coverage and plant age on SO_2 sensitivity were tested among rice, soybean and corn plants. The main objective of the conducted experiments was to provide useful data for SO_2 pollution management using the extensively cultivated crop species. Among 20 rice varieties tested, Japonica rice generally performed better than Indica rice in regarding to resistance to SO_2 damage. Palmetto and Yellamel soybean were among 5 tested soybeans the most resistant. And all 5 tested corn varieties were quite resistant to the applied SO_2 treatment. The elevation of temperature from 25 to 35℃ greatly reduced the SO_2 resistance of most tested rice and soybean plants; although the observed temperature effect did not hold for the corn varieties tested. The injury of SO_2 on all tested rice plants was greatly reduced by provision of 60% coverage shading. The protective effect of shading, however, was not so evident on soybean and corn plants tested. Generally the SO_2 resistance among all 3 tested crop species increased with the increase of plant age. The only exception was that for the susceptible Indica rice like Tainung Sen-20 or Kaoshiung Sen-2 cultivars. The obtained results indicated clearly that the SO_2 sensitivity of the 3 tested crops depended greatly on their varietal characteristics which were further complicated by the change of temperature, light intensity and plant age. In regarding to the deployment of these 3 extensively cultivated crops for SO_2 pollution management, the presented data are useful. Further investigation to elucidate the factors contributing SO_2 to sensitivity is needed.

Key word: rice, corn, soybean, sulfur dioxide.

INTRODUCTION

Sulfur dioxide has become one of the prevailing phytotoxic air pollutants in Taiwan recently due to the intense industrialization, prosperous social development, and the accompanied increase of demands in electric power generation and refined fuel consumption. The problem appears to be most prominent among the densely populated urban area as well as the heavily industrialized area. It poses great threats not only to the health of human residents, but also to the yield and quality of crop production. The reduction or prevention of the deleterious effect of sulfur dioxide has become one of the routine administrative emphases of the Taiwan Environmental Protection Administration (EPA). Biomonitoring the pollutants and substantial diminution of the sulfur dioxide in the air have been primed focuses of research among quite a few biology-related disciplines including plant pathology.

The sensitivity of crop plants to SO_2 was known to be quite diversified among different species and cultivars. The sensitive ones may be useful as bioassay host for monitoring the status of SO_2 in the air, whereas the resistant or tolerant ones may be beneficial in diminishing SO_2 content in the air. Deployment of sensitive indicator plants is one of the methods recommended for the on-site monitoring of potential risks due to this pollutant. A main restriction for its application, however, is the need of great number of indicator plants in order to collect a representative data. Another limitation, which may discourage such application, is the lack of interests among general publics to grow plants without appealing ornamental or practical values. To resolve these limiting problems, the use of existing food crop species with wide cultivation acreage appears to be an alternative. With this in mind, different cultivars of rice, soybean and corn—the 3 most extensively cultivated crops in Taiwan, were tested for their sensitivity to SO_2. Substantial differences of SO_2 sensitivity were detected among varieties of tested plant species and among plants at different developmental stages. The observed varietal difference was found affected by temperature, shading and plant age. The significance of the observed consequences in the attempt to alleviate the SO_2 issue by deployment of widely cultivated crops is herein addressed.

MATERIALS AND METHODS

A total of 20 rice (as shown in Table 1), 5 soybean (as shown in Table 2), and 5 corn (as shown in Table 3) varieties were used for the experiment. The plant cultivars were chosen according to their differential sensitivities to SO_2 damage as that reported by Shiau et al., (11). The test plants were grown in closed glass chambers used for SO_2 treatment as that described in the same paper (11). Seeds of soybean and corn were directly sown in sandy loam mixed with 5% of organic manure in 60 (length) × 17 (height) × 17 cm (width) and 25 cm (diameter) plastic pots, respectively. After germination, approximately 2 g of complex Tai-fertilizer No.5 was top dressing applied every 10 days to each pot. Rice seeds were disinfected with prochloraz at 2,000 X and sown in a tray for 4 weeks and then transplanted in 60 × 17 cm pots. Two grams of urea were top dressing applied every 10 days thereafter starting 10 days after transplanting. Temperatures of the treatment chambers were controlled by air conditioners. Whereas the relative humidity were regulated and maintained by Herrmidifiers. A Sato thermohygrography (model R-704) was used to record the changes of temperature and RH automatically. The glass chambers adapt mainly natural light, the light intensity was measured by a LI-COR radiometer (model LI-185A). When the plants were not fumigated with SO_2, the doors and windows of the chambers were kept open and the RH and temperature resumed to ambient conditions.

The SO_2 concentration within the treatment chamber was constantly monitored by a SO_2 analyzer (Monitor Labs model 8850) which was equipped with a Monitor Labs calibrator (model 8550). The precision of SO_2 analyzer was calibrated weekly during the fumigation treatment. For the fumigation treatment, SO_2 concentration within the chamber was kept at 800 ppb consistently. The fumigation was generally

TABLE 1. Effect of varietal difference and temperature on the severity of injury of rice plants by sulfur dioxide[1]

Varieties	Temperature(C)		
	25	30	33
Indica rice			
IR 1545-339	56.67 a[2]	58.33a	58.93 a
Kaohsiung Sen 2	61.27 a	57.73 a	64.80 a
Kaohsiung Sen 7	44.60 b	62.00 a	63.35 a
Taichung Sen 5	42.71 a	33.33 b	47.92 a
Taichung Sen 16	33.33 a	47.80 a	40.94 a
Taichung Sen 20	42.35 b	54.08 b	74.68 a
Japonica rice			
Cas 290	29.82 b	27.27 b	36.11 a
Chianan 1	12.25 ab	9.42 b	18.39 a
Chianan 3	10.77 b	10.00 b	23.23 a
Chianan 5	11.54 b	14.85 ab	21.33 a
Taichung glutinous 70	9.06 b	7.41 b	15.59 a
Tainung 37	16.24 a	2.34 b	7.57 b
Tainan 5	13.47 b	14.07 b	25.81 a
Tainung 16	9.32 b	4.56 b	17.16 a
Tainung 67	10.61 b	14.08 b	32.55 a
Taipei 139	10.54 b	11.98 b	26.55 a
Taipei 306	11.49 b	22.96 a	27.38 a
Taitung 25	8.93 b	16.74 ab	19.31 a
Taitung 28	12.35 ab	6.25 b	20.35 a
Taitung 29	23.69 a	25.06 a	27.25 a

1. Plants at 30 days after transplanting were fumigated for 6 days, 6 hrs/day.
2. Degree of injury (%); data are means of two replicates. Values within a row followed by the same letter are not significantly different at P = 0.05 according to Duncan's new multiple range test.

TABLE 2. Effect of varietal difference and temperature on the severity of injury of soybean by sulfur dioxide[1]

Varieties	Temperature(C)		
	25	30	35
Palmetto	14.01 b[2]	38.58 a	49.63 a
Hybrid 2217	33.77 b	49.40 ab	59.62 a
Kaoshiung sel. 10	10.61 b	28.96 ab	38.15 a
Acadianex dcragen	3.20 a	7.68 a	11.26 a
Yellamel	4.38 b	13.38 ab	22.29 a

1. Plants were treated 32 days after sowing for 4 days (8 hrs/day)
2. Degree of injury (%), data are means of eight replicates. Values within a row followed by the same letter are not significantly different at P = 0.05 according to Duncan's new multiple range test.

TABLE 3. Effect of varietal difference and temperature on the severity of injury of corn by sulfur dioxide[1]

Varieties	Temperature(C)		
	25	30	35
Tainan 5	7.72 a[2]	5.28 ab	3.81 b
Tainung 351	11.21 a	9.70 a	8.18 a
Honey	2.45 a	0.92 a	3.23 a
Sweet 236	2.88 a	1.96 a	1.74 a
Tainan 10	6.97 a	9.07 a	5.74 a

1. Plants were treated 10 days after sowing for 5 days (8 hrs/day).
2. Degree of injury (%), data are means of eight replicates. Values within a row followed by the same letter are not significantly different at P = 0.05 according to Duncan's new multiple range test.

conducted during sunny days, starting at 9 am and ending at 3 to 5 pm depending on whether treatment was 6 or 8 hr daily. Unless specifically stated the relative humidity and temperature in the fumigation chambers were kept at 65-80% and 30±2 C, respectively. The development of symptoms was then followed by a time course study. The severity of SO_2 damage was evaluated by the same methodology described in the earlier report (11).

RESULTS

Effect of varietal difference and temperature on SO_2 damage

Rice plants at 30 days after transplanting were used for the sensitivity test. The twenty tested rice varieties were fumigated with SO_2 6 hr/day at 25, 30, and 33 C respectively. Among tested varieties, Indica rice appeared to be more vulnerable to SO_2 damage as compared to that of Japonica rice (Table 1). The sensitivity among these varieties was manifested by the extensive necrotic lesions which was in general observed one day after treatment. After 6 days consecutive fumigation treatment, necrotic lesion among these varieties has reached or exceeded 50% of the foliar tissues. Taichung Glutinous 70, and Tainung 16 or 37, in contrast, appeared to be most resistant to the applied SO_2 treatment. The severity of disease symptom on these two varieties remained at approximately 2 to 16 % in the same treatment. Most of the Japonica rice tested also appeared to be quite tolerant; the severity of foliar symptom was mostly around 10 to 30 % after 6 days treatment. The severity of symptom development among most tested plants appeared to be dependent on the increase of temperature. A total of nine varieties, Kaohsiung Sen 2, Tainung 16, Taitung 28, Taichung Sen 16, Taipei 306, Chianan 3, Tainan 5, Tainung Sen 20 and Taichung glutinous 70, showed brownish flecks on leaves on the first day of treatment at 33 C. At 30 C, only Taitung 28, Tainung 67, Taichung glutinous 70 and Chianan 5 showed symptoms on the first day of treatment. And at 25 C, none of the tested rice plants developed symptoms on the first day of treatment. Varietal sensitivity of rice plants at three temperatures as shown on Table 1 revealed that degree of injury at 25 and 33 C was significantly different on sixteen varieties. In general, the higher the temperature, the more severe were the symptoms. However, in some sensitive Indica varieties the temperature effect was considerably less evident.

Five soybean varieties at 32 days after sowing, and five corn varieties at 10 days after sowing were subjected to SO_2 treatment 8 hr/day at 25, 30, or 35 C for 4 and 5 days, respectively. Similar to that of rice, the varietal difference and temperature effect were also evident among tested soybean (Table 2) and corn varieties (Table 3). Acadianex dcragen was among tested soybeans the most resistant, the severity of foliar symptom after 4 days fumigation remained at about 10 % level even at 35 C. On the sensitive variety such as Hybrid 2217, as a comparison, the severity of injury has reached close to 60 % in the same experiment. High temperature enhanced significantly SO_2 damage to most tested soybean, although on Acadianex dcragen (Table 2) the difference among three test temperatures was not significant. At the applied dosage, the degree of injury of corn plants by SO_2 (Table 3) was much less evident as compared to that of rice (Table 1) and soybean plants (Table 2). The disease severity among these tested corn varieties nearly all remained at less than 10 % level after five days fumigation. Furthermore, the enhancement of damages due to temperature increases was not significant among tested corn plants.

Effect of shading on SO_2 damage

Seventeen rice (Table 4), 5 soybean (Table 5) and 5 corn (Table 6) varieties were used for the experiment. The tested plants were subjected to full sunlight exposure or under shading. Covering the glass chamber with two layers of black net (approximately 60% coverage) provided the shading during SO_2 fumigation. By shading sunlight, the damages of SO_2 on rice plants were reduced significantly (Table 4). The sensitive varieties under full sunlight showed symptoms mostly on the first day of treatment. Whereas in a shaded condition, symptom development was generally delayed for one day. For the resistant rice varieties (e.g. Tainung 16), the shading treatment reduced the symptom even to a non-detectable level. The shading effect was also apparent on most sensitive indica varieties (Table 4). For tested soybean and corn varieties, shading also provided certain degree of protection against SO_2 damage (Tables 5 & 6). Effective protection provided by shading was observed on both Palmetto soybean and Tainan 5 corn plants. However, unlike that of rice plants, the differences of symptom severity among the shaded and non-shaded treatments remained not significant among other soybean (Table 5) and corn (Table 6) varieties tested.

TABLE 4. Effect of shading on the severity of injury of rice plants by sulfur dioxide [1]

Varieties	Shaded[2]	Non-shaded
Indica rice		
IR 1545-339	28.33 a	37.04 a
Kaohsiung Sen 2	24.23 a	49.96 b
Kaoksiung Sen 7	8.16 a	33.79 b
Tainung Sen 20	3.60 a	44.02 b
Japonica rice		
Chianan 1	2.86 a	9.52 b
Chianan 3	1.92 a	9.56 a
Chianan 5	7.09 a	14.70 a
Taichung glutinous 70	2.29 a	11.18 b
Tainan 5	7.38 a	17.11 b
Tainung 16	0.00 a	7.50 b
Tainung 37	7.38 a	6.85 a
Tainung 67	4.19 a	13.89 b
Taipei 139	2.64 a	4.06 a
Taipei 306	1.92 a	14.41 b
Taitung 25	5.84 a	16.89 b
Taitung 28	8.83 a	13.83 a
Taitung 29	8.66 a	13.19 a

1. Plants at 30 days after transplanting were fumigated for 6 days, 6 hr/day.
2. Average light intensity of non-shaded: 1701 Lux and shadd: 228 Lux.
3. Degree of injury (%), data are means of two replicates. Values within a row followed by the same letter are not significantly different at P = 0.05 according to Duncan's new multiple range test.

TABLE 5. Effect of shading on the severity of injury of soybean plants by sulfur dioxide [1]

Varieties	Shaded[2]	Non-shaded
Palmetto	3.74 b[2]	10.59 a
Hybrid 2217	7.33 a	16.70 a
Kaoshiung sel. 10	1.64 a	4.84 a
Acadianex dcragen	1.07 a	0.61 a
Yellamel	2.10 a	1.67 a

1. Plants were treated 30 days after sowing for 8 days (8 hrs/day).
2. Degree of injury (%), data are means of four replicates. Values within a row followed by the same letter are not significantly different at P = 0.05 based on Duncan's new multiple range test.

TABLE 6. Effect of shading on the severity of injury of corn plants by sulfur dioxide [1]

Varieties	Shaded[2]	Non-shaded
Tainan 5	3.81 b[2]	9.94 a
Tainung 351	10.40 a	17.02 a
Honey	2.77 a	3.79 a
Sweet 236	5.94 a	5.96 a
Tainan 10	8.63 a	5.15 a

1. Plants were treated 10 days after sowing for 5 days (8 hrs/day).
2. Degree of injury (%), data are means of four replicates. Values within a row followed by the same letter are not significantly different at P = 0.05 according to Duncan's new multiple range test.

Effect of plant ages on SO_2 sensitivity

The tested plants included 5 rice (Table 7), 3 soybean (Table 8), and 5 corn (Table 9) varieties. Rice plants at 45, 55, 65, 75, 85 and 95 days after transplanting; soybean plants at 31, 41, 51 and 61 days after sowing; and corn plants at 10, 20, 30, 40 and 50 days after sowing were used for the fumigation treatment. For rice plants, the symptom development after 13 days treatment (6 hrs continuous fumigation daily) generally indicated that plants at younger

TABLE 7. Effect of plant age on the sensitivity of pot-grown rice plants to sulfur dioxide [1]

Days after transplanting	Varieties[2]				
	Tn S-20	Kn S-2	Tt-29	Tc G-70	Tn-37
95	10.94 d[3]	56.79 a	4.68 c	3.27 d	1.75 e
85	29.49 bc	54.89 ab	15.08 b	7.02 cd	3.07 de
75	24.12 c	49.16 bc	12.41 b	5.41 d	6.48 cd
65	35.14 ab	52.64 ab	23.32 a	12.90 b	11.80 ab
55	25.46 c	35.98 d	16.40 b	9.62 bc	9.59 bc
45	41.92 a	44.55 c	28.88 a	16.94 a	13.78 a

1. Plants were treated for 13 days, 6 hrs/day.
2. Tn S-20 = Tainung Sen 20, Kh S-2 = Kaohsiung Sen 2, Tt-29 = Taitung 29, Tc G-70 = Taichung Glutinous 70,Tn-37 = Tainung 37.
3. Degree of injury (%), data are means of eight replicates. Values within a column followed by the same letter are not significantly different at P = 0.05 according to Duncan's new multiple range test.

TABLE 8. Effect of plant age on the sensitivity of pot-grown soybean plants to sulfur dioxide[1]

Varieties	Days after sowing			
	31	41	51	61
Palmetto	23.88 a[2]	19.97 a	10.82 b	1.69 c
Kaoshiung sel.10	15.36 a	15.23 a	15.43 a	1.13 b
Hualen 2	5.66 b	19.29 a	2.65 b	0.47 b

1. Plants were treated for 10 days, 8 hrs/day.
2. Degree of injury (%), data are means of nine replicates. Values within a row followed by the same letter are not significantly different at P = 0.05 according to Duncan's new multiple range test.

TABLE 9. Effect of plant age on the sensitivity of pot-grown corn plants to sulfur dioxide [1]

Varieties	Days after sowing				
	10	20	30	40	50
Tainan 5	59.42 a[2]	28.84 b	13.78 c	7.42 c	8.23 c
Tainung 351	82.20 a	54.49 b	40.26 bc	25.69 c	10.01 d
Honey	61.64 a	47.65 ab	35.02 bc	19.50 cd	12.21 d
Sweet 236	81.95 a	53.31 b	26.88 c	14.70 cd	7.40 d
Tainan 10	70.41 a	57.07 ab	36.72 bc	26.03 cd	9.81 d

1. Plants were treated for 8 days, 8 hrs/day.
2. Degree of injury (%), data are means of four replicates. Values within a row followed by the same letter are not significantly different at P = 0.05 according to Duncan's new multiple range test.

stage were more vulnerable to SO_2 damage than old ones. The juvenility effect was especially evident for the resistant Japonica rice. For the susceptible indica rice like Kaohsiung Sen 2, most severe symptom was observed among 85- and 95-day plants (Table 7). The effect of plant age on SO_2 sensitivity of both soybean (Table 8) and corn (Table 9) plants tested was similar to that of rice plants in that the resistance generally increased with plant age. In the corn trial, the tested plants were fumigated for 8 days, in stead of 5 days, to intensify the SO_2 damage. The effect of prolonged treatment time was clearly reflected by the greatly increased symptom severity among the plants at 10 to 20 days' young stage. However, among plants approaching 40 to 50 days' stage, the SO_2 sensitivity was greatly reduced.

DISCUSSION

For the symptom development of plants due to biological or non-biological stresses, it is very much dependent on the varietal characteristics, environmental conditions, and applied dosages. The varietal difference of tested rice, soybean and corn in SO_2 sensitivity shown above clearly indicated that selection of a suitable variety is rather critical while attempting to use them for air pollution control. In the case of rice production, in an area where SO_2 pollution is a severe problem, the resistant Japonica rice like Taichung Glutinous 70 and Tainung 16 or 37 appeared to be suitable varieties for cultivation. As regard to soybean production, Acadianex dcragen and Yellamel were the kind of choice. Whereas for tested corn, the varietal differences were not evident. The observed tolerance among these corn varieties suggested their possible application in the pollution control. As a contrast, for the application of pollution monitoring in an area where SO_2 problem is mild or only incidental, all six tested Indica rice and Hybrid 2217 soybean appeared to be the kind of choices.

The significant increase of SO_2 injury along with increased temperature was commonly observed on rice and soybean. The results were similar to that reported by Heck & Dunning (3) and Rist & Davis (7) in that the severity of symptoms on oats and pinto bean leaves due to SO_2 injury was greater at higher temperature and relative humidity. The increase of stomatal conductance was found to be a plausible reason for the observed SO_2 sensitivity along with increased temperature and relative humidity (9). Whether or not the same reason also applies to that observed on rice and soybean remains to be determined. The increased SO_2 sensitivity was generally manifested by an earlier and increased severity of symptoms. The severity of symptoms clearly reflected the plant resistance to SO_2 damage. However, it was noted that an early symptom development did not necessarily correlate with the level of resistance of the test varieties. The early symptom development on the resistant variety-such as Taichung Glutinous 70 or Tainung 16 seemed to indicate an acute physiological response of test plants due to the applied SO_2 stress. Whether this may play certain role in the disease resistance deserve further attention. The lack of effectiveness of temperature increase on SO_2 sensitivity of corn (Table 3) indicated the possibility of the increased plant vigor at a raised temperature regime.

Effect of shading treatment significantly reduced the damage of SO_2 among the three tested plants (Tables 4, 5 & 6). As stomata are the main entry for SO_2 to get into the plant (3, 4, 6, 8, 9), their functions are very much dependent on light illumination. The protective effect of shading was evidently a function of reduced stomatal opening and leaf temperature due to the reduced light intensity. In a recent report of Meng et al. (5), the authors indicated that in shadeadapted foliage of spruce, visible symptoms due to SO_2 damage were generally delayed as compared those not in shade. Another plausible reason for the protective role provided by shading was the reduction of photodynamic effect and the reduced auto-oxidation. The effectiveness of shading was more prominent on rice plants as compared to that of soybean and corn plants. In a shaded condition, sensitive Indica rice, e.g. Kaohsiung Sen 7, showed a fairly mild symptom comparable to that of a resistant Japonica rice.

The plant age and developmental status also affected their sensitivity to SO_2. In general, the young plants were more sensitive than mature plants. However Berry (1) reported that pine seedlings were most sensitive to SO_2 at or older than 8 to 10 weeks; seedlings at an earlier stages of development were relatively less sensitive. Similarly, the comparison of SO_2—caused symptoms among the upper young leaves and lower mature leaves of the plants including soybean, members of Cucurbitaceae, and peas, all indicated that the younger ones are usually more tolerant to SO_2 than older ones (2, 7, 10, 12). The protective effect provided by the juvenility indicated the presence of certain protective factors among these young tissues.

The data presented indicated clearly that SO_2 sensitivity of rice, soybean and corn plants were greatly affected by the varietal difference, temperature, shading of light and the developmental stages. In general, the sensitivity of these three crop species was greatly favored by increased temperature, light intensity and plant juvenility. It was evident that the sensitivity of a crop species to SO_2 depended greatly on the overall performance of its genetic makeup, which was complicated by the effect of above mentioned factors. For the proper management of SO_2 caused impacts by deployment of extensively cultivated crops, further investigation to elucidate the factors contributing to their sensitivities is very important.

ACKNOWLEDGMENTS

This research was supported in part, respectively, by Department of Agriculture and Forestry, Taiwan Provincial Government, and Council of Agriculture, Executive Yuen, R. O. C.

LITERATURE CITED

1. Berry, C. R. 1974. Age of pine seedlings with primary needles affects sensitivity to ozone and sulfur dioxide. Phytopathology 64:207-209.
2. Grunwald, C. 1981. Foliar fatty acids and sterols of soybean field fumigated with SO_2. Plant Physiol. 68:868-871.
3. Heck, W. W., and Dunning, J. A. 1978. Response of oats to sulfur dioxide: interactions of growth temperature with exposure temperature or humidity. J. Air Pollut. Control Assoc. 28:241-246.
4. Mclaughlin, S. B., and Taylor, G. E. 1981. Relative humidity: important modifier of pollutant uptake by plants. Science 211:167-168.
5. Meng, F. R., Cox, R. M., and Arp. P. A. 1994. Fumigation mature spruce branches with SO_2: effect on net photosynthesis and stomatal conductance. Can. J. For. Res. 24:1464-1471.
6. Olszyk, D. M., Bytnerowicz, A., Fox, C. A., Kats, G., Dawson, P. J., and Wolf, J. 1987. Injury and physiological responses of *Larrea tridentata* (DC) Coville exposed in situ to sulphur dioxide. Environ. Pollut. 48:197-211.
7. Olszyk, D. M., and Tibbites, T. W. 1982. Evaluation of injury to expanded and expanding leaves of peas exposed to sulfur dioxide and ozone. J. Amer. Soc. Hort. Sci. 107:266-271.
8. Rosen, P. M., Musselman, R. C., and Kender, W. J. 1978. Relationship of stomatal resistance to sulfur dioxide and ozone injury in grapevine. Sci. Hortic. 8:137-142.
9. Rist, D. L., and Davis, D. D. 1979. The influence of exposure temperature and relative humidity on the response of pinto bean foliage to sulfur dioxide. Phytopathology 69:231-235.
10. Sekiya, J., Wilson, L. G., and Filner, P. 1982. Resistance to injury by sulfur dioxide: correlation with its reduction to, and emission of hydrogen sulfide in Cucurbitaceae. Plant Physiol. 70:437-441.
11. Shiau, J. F., Hsieh, S. P. Y., Kao, S. T., Leu, M. C., and Yang, J. S. 1993. Varietal sensitivities of rice, soybean and corn to sulfur dioxide. Plant Pathol. Bull. 2:43-51.
12. Smith, H. J., and Davis, D. D. 1977. The influence of needle age on sensitivity of Scotch pine to acute doses of SO_2. Plant Dis. Rep. 61:870-874.

摘　　要

謝式坪鈺、呂明長、高碩廷、蕭淑芬、曾德賜 1998. 品種差異溫度、遮光及株齡等對水稻、玉米及大豆等作物對二氧化硫敏感性的影響。植病會刊 7:113-119. (台中市　國立中興大學　植物病理學系)。

本研究測試品種差異及株齡等對水稻、玉米和大豆對空氣污染物二氧化硫敏感性之影響，主要研究目的在了解利用這些大面積栽培作物改善二氧化硫污染之可行性。於 20 供試水稻品種中，稉稻對二氧化硫危害具有抗性，五種大豆品種中以 Palmetto 及 Yellamel 兩品種較具抗性，而所有五種供試玉米品種則均對二氧化硫具相當程度之抗性。溫度越高大部分供試水稻品種受二氧化硫傷害也越大，但溫度對數種敏感的秈稻並不影響。大豆於高溫 (35℃) 下較敏感，低溫 (25℃) 下則具耐性，但溫度對玉米之影響不大。水稻在 60% 遮光處理下，可使二氧化硫傷害顯著降低，此在秈稻品種上尤為明顯。遮光並不影響大豆和玉米對二氧化硫之反應，僅敏感性品種稍受影響。一般而言，此三種作物對二氧化硫之抗性均有隨株齡而提高之現象，台中 20 號及高雄秈 2 號兩敏感品種為唯一例外。綜合上述試驗結果可明顯看出三種供試作物種類對二氧化硫之敏感性與品種特性有密切關係，且受溫度、光照與株齡之影響相當大，在二氧化硫污染管理應用上，本研究所提供試驗結果極具參考價值，有關二氧化硫敏感性決定因子闡明將為未來繼續探討之重點。

關鍵字：水稻、玉米、大豆、二氧化硫。